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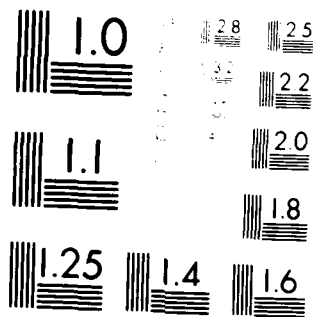
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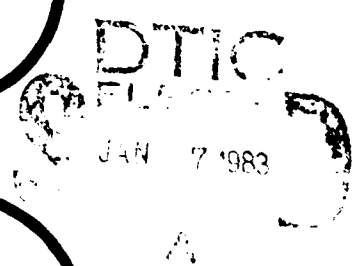
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# WORKBOOK FOR TESTING IN NAVY SCHOOLS



**NAVY PERSONNEL RESEARCH  
AND  
DEVELOPMENT CENTER  
San Diego, California 92152**

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**WORKBOOK FOR TESTING IN NAVY SCHOOLS**

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## FOREWORD

This effort was conducted under program element 63720N, project Z1175.PN (Training System Design and Management), subproject 05 (Improved Effectiveness in Course Design, Delivery, and Evaluation) and was sponsored by the Deputy Chief of Naval Operations (Manpower, Personnel, and Training) (OP-01). The objective of the subproject is to develop an empirically-based instructional design support system to aid developers in choosing instructional alternatives based on costs/benefits and specific resource limitations.

This workbook, which is intended for use in conjunction with The Handbook for Testing in Navy Schools (NPRDC SR 83-2), was designed to provide training in the test item and test development procedures described in the handbook. It can also be used to conduct workshops on criterion-referenced testing or for self-study. It consists of a series of practice exercises, with feedback, on how to construct criterion-referenced tests. It is divided into sections that correspond with sections of the handbook.

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Commanding Officer

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## TESTING REMEMBER-LEVEL OBJECTIVES

### Instructions

For this exercise, you will write test items for the list of 20 objectives given below. The exercise has two parts. The first part requires you to write test items that are consistent with the objectives and the second asks you to write inconsistent test items.

For the first part, objectives 1 through 11, all items are constructed-response. For the second part, objectives 12 through 20, the type of item(s) to be written is given immediately following the objective.

The second part is designed to help you deal with constraints on testing. These items types should be used only when absolutely necessary. For multiple-choice items in the second part that require subject matter expert knowledge to develop alternatives, do not write the alternatives; instead, just indicate a. b. c. etc. If the objective calls for a series of multiple-choice items, just write one prototype item.

Remember, before you try to write the test item, you should classify the objective and then look up the appropriate item format in the handbook.

If paraphrasing would be appropriate, make a note of it when you write the item.



### Consistent Test Items

1. The student will write from memory the principles of operation of a rotary-gear pump as described in Tech. Manual 34A.
2. The student will recall in writing what will happen if tube oil in the landing gear of an F-18 aircraft is contaminated by insoluble materials.
3. The student will write from memory the correct sequence of steps for testing common transistors using a Simpson 2601 multimeter.
4. Given a diagram of the NCR Cash Register, the student will label the parts.
5. The student will write from memory the procedure for setting the dwell angle in a GM half-ton truck.
6. The student will recall in writing the names of the following 10 schematic symbols: (1) ..., (2) ..., etc.
7. The student will recall in writing the major steps from origination to passage of a bill in the U.S. Congress, as listed in the text.
8. The student will recall in writing the functions of each of the control knobs on the SQQ89 sonar.
9. Given a picture of any wrench, the student will orally recall the name of the wrench.
10. The student will write from memory the Ohm's Law formula ( $I=E/R$ ) for calculating total current in a circuit.
11. The student will describe the radar signal parameter measurement characteristics of SPS and PRF that are used in identifying circular sector, conical, and steady types of scans on an analysis scope and by listening to audio output.

### Inconsistent Test Items

These item formats should only be used when there are constraints on testing. Paraphrasing should be used when possible. You should be familiar with the sections in Chapter 3 of the handbook on "Paraphrase Test Items," "Rules and Guidelines for Writing Test Items," and "Constraints on Testing" before completing this exercise.

12. The student will write from memory, in the proper order, the procedures performed by a gun captain while firing during general quarters. Write a series of multiple-choice items.

13. The student will write from memory, in the proper order, the steps of the procedure for message reception and duplicate checking as listed in the current edition of NTP-4. Write a series of multiple-choice items.

14. The student will label on a diagram all the components of the water cooling system for a GM6-71 series diesel engine. Write a matching item.

15. The student will write from memory the six pieces of silverware used for a formal dinner setting. The silverware should be listed in order from left to right. Write a matching item.

16. The student will list from memory the four types of messages that may be broadcast on a TADIL net. Write a series of multiple-choice items.

17. The student will write from memory the functions of the following objects as given in technical manual xxy: metal fastener, wrench, reciprocating pump, reducing valve, worm gear, and micrometer. Write a series of multiple-choice items.

18. The student will write from memory the names of the electronic variables represented by the following letters: I, E, and R. Write a matching item.

19. The student will write from memory the names and characteristics of each of the following types of Navy call signs: international U.S. Navy ship, international U.S. Navy shore, indefinite, task organization, and voice. Write a series of multiple-choice items.

20. The student will recall orally the steps of the procedure for sharpening a pocket knife as listed in NAVPERS 93438-1B. Write a matching item.

### Feedback for Consistent Test Items

1. In the space below, describe the principles of operation of a rotary-gear pump. Your answer should include all the principles discussed in Tech. Manual XXX.
2. In the space below, explain what will happen to the landing gear mechanism of an F-18 aircraft if the lubricating oil is contaminated by insoluble materials.
3. In the space below, write the steps for testing common transistors using a Simpson 260P multimeter, in the correct order.
4. Label the diagram of the NCR cash register pictured below.
5. In the space below, write the steps for setting the dwell angle in a GM half-ton truck, in the correct order.
6. For each of the schematic symbols pictured below, write the name of the symbol in the blank next to the symbol.
7. In the space below, write the major steps a bill takes from origination to passage to get through the U.S. Congress. The steps must be written in the correct order.
8. Below is a picture of the control panel for the SQQ89 sonar. There is an arrow drawn from each of the control knobs to a blank line. Write the function of each knob on blank line for that knob.
9. When I point to a picture of a wrench on this poster, I want you to tell me the name of the wrench.
10. Write the Ohm's Law formula for calculating total current in a circuit.
11. In the space below, describe the radar signal parameter measurement characteristics of SPS and PRF that are used in identifying circular sector, conical, and steady types of scans on an analysis scope and by listening to audio output.

Feedback for Inconsistent Test Items

12. The form for a series of multiple-choice items for this objective is as follows:

Which of the following is the (step number) step of the procedure performed by a gun captain while firing during general quarters?

- a. ...
- b. ...
- c. ...
- d. ...

The alternatives should be the other steps of the procedure. Paraphrasing should be used when possible.

13. The form for a series of multiple-choice items for this objective is as follows:

Which of the following is the (step number) step of the procedure for message reception and duplicate checking as listed in the current edition of NTP-4?

- a. ...
- b. ...
- c. ...
- d. ...

The alternatives should be the other steps of the procedure. Paraphrasing should be used when possible.

14. Below is a diagram of GM6-71 series diesel engine. Each component of the cooling systems has a letter. You must match that letter with the appropriate component name. The component names are listed on the right-hand side of the page. A blank is provided next to each name. Write the appropriate letters in the appropriate blanks.

15. Below are pictured the six pieces of silverware used for a formal dinner. Each piece is numbered. Match each number with the appropriate name. The names are listed on the right side of the page. Write the appropriate number in the blank next to each name. Next, on the six blank lines at the bottom of the page, arrange the numbers in the correct order that the silverware would appear on the table from left to right.

16. There should be four multiple-choice items for this objective. They should take the following form:

Which of the message types listed below may be broadcast on a TADIL net?

- a. ...
- b. ...
- c. ...
- d. ...

The alternatives should be message types that are broadcast on other types of nets. Paraphrasing cannot be used here.

17. The form for a series of multiple-choice items for this objective is as follows:

Which of the statements below describes the function of the (object name)?

- a. ...
- b. ...
- c. ...
- d. ...

The alternatives should be the functions of the other objects. Paraphrasing should be used when possible.

18. Match the letters in column A with the electronic variable names in column B.

19. The multiple-choice items for this objective should have the following form:

Which of the sets of characteristics given below are the characteristics of the (Call Sign name)?

- a. charac. a, charac. b, charac. c
- b. charac. d, charac. e, charac. f
- c. charac. g, charac. h, charac. i
- d. charac. j, charac. k, charac. l

Paraphrasing cannot be used.

20. Match each of the steps for sharpening a pocket knife listed below with the appropriate number for that step. Write the correct step number in the blank next to each step. To be correct, you must use the order of steps given in NAVPERS 92438-1B.

## TESTING A USE-PROCEDURE OBJECTIVE

### Instructions

In this exercise, you will be given a USE-PROCEDURE objective. Your task is to use the guidelines in "Rules for Designing Test Items for USE-PROCEDURE Objectives" (Chapter 4 of the handbook, page 75). You should (1) determine whether a product, process, or both should be evaluated, (2) determine whether a simulation should be used, (3) develop the product/process measurements--including actual checklists/rating scales and the directions for their administration, (4) decide how many times the procedure should be performed, and (5) develop any REMEMBER-level test items that need to be tested during the USE-PROCEDURE test.

The information needed to do this is included here and in the handbook. Look at the main ideas to be considered under "Testing USE-PROCEDURE Objectives" (page 75) before you begin item development.

### Exercise

#### Objective

Given a sharp knife (use a felt tip pen to simulate a sharp knife), matches, and a scarf, the student will demonstrate first aid for a simulated snakebite when the victim develops severe symptoms, is breathing, and has a pulse. The nearest hospital is over five hours away. Simulate the cuts across the bite with a felt-tip pen.

#### First Aid for Snakebite

The following information is taken from the American Red Cross pamphlet (1980) on "first aid for snakebite."

#### First Aid for Snakebite

The victim of a snakebite must have prompt medical attention. The most important step is to get the snakebite victim to the hospital quickly. Meanwhile, take the following first aid measures:

1. Keep the victim from moving around.
2. Keep the victim as calm as possible and preferably in a lying position.
3. Immobilize the bitten extremity and keep it at or below heart level.

If the victim can reach a hospital within 4 or 5 hours and if no further symptoms develop, no further first aid measures need be applied.

4. If mild-to-moderate symptoms develop, apply a constricting band 2 to 4 inches above the bite, but not around the head, neck, joints, or trunk. The band should be between the bite and the heart.

The band should be 3/4 to 1-1/2 inches wide, not thin like a rubber band. The band should be snug but loose enough for a finger to be slipped underneath. Watch for swelling. Loosen the band if it becomes too tight, but do not remove it. Periodically check the pulse in the extremity beyond the bite to ensure that the blood flow has not stopped.

5. If severe symptoms develop, keep the victim lying down and comfortable and maintain his body temperature. If breathing stops, give mouth-to-mouth resuscitation. If there is no pulse, perform cardiopulmonary resuscitation (CPR)--if you have been trained to do so.

As soon as possible make an incision over each fang mark and apply suction immediately. Apply a constricting band (see Step 4) if that has not already been done, and make cuts in the skin through the fang marks. Use a sharp, sterilized knife. Matches can be used to sterilize the knife. Cuts should be no deeper than just through the skin and should be 1/2 inch long, extending over the suspected venom deposit point. (Because a snake strikes downward, the deposit point is usually lower than the fang mark.) Cuts should be made along the long axis of the limb. Do not make cross-cut incisions. Do not make cuts on the head, neck, or trunk or joints.

Apply suction with a suction cup for 30 minutes. If a suction cup is not available, use your mouth. There is little risk to the rescuer who uses his mouth, but it is recommended that the venom not be swallowed and that the mouth be rinsed out.

If the hospital is not close--that is, if it cannot be reached in 4 or 5 hours--take the following measures:

1. Keep trying to obtain professional care, either by transporting the victim to a place where medical care is available or by using an emergency communications system to obtain medical advice.

2. If no symptoms develop, keep trying to reach the hospital and give the general first aid described above in steps 1, 2, and 3.

3. If any symptoms at all develop, apply a constricting band, make incisions, and apply suction immediately, as described above in steps 4 and 5.

Use the above information and the handbook with the steps below to develop an evaluation of the procedure and any necessary testing of REMEMBER-level items.

Step 1. Determine TASK LEVEL and CONTENT TYPE. Before you start anything you should classify the objective and determine if you are in the right chapter.

Steps 2 and 3. Determine if the Objective Specifies a Product and Determine Whether to Test Product, Process, or Both. Refer back to the objective to decide if a tangible product or process or both result from the procedure. Steps 2 and 3 are related to the product/process decision about what should be evaluated. Make some notes about what you decide.

Step 4. Determine Whether Simulation is Necessary or Desirable. Here the objective already specifies a simulated demonstration.

Steps 5 and 7. Analyze the Process and Determine Whether to Use Checklists and/or Rating Scales. Look at the Red Cross information on what to do if severe symptoms develop. Analyze the procedure into discrete steps. Decide whether a checklist or rating scale is the most appropriate measurement method for each step.

Step 6. Analyze the Product. N/A

Steps 8 and 9. Develop Checklists and Develop Rating Scales. After the steps are specified, decide which measurement method--a rating scale or a checklist--can be used best to evaluate that step and then develop the lists or scales. For purposes of this exercise, only develop checklists and/or rating scales for the section dealing with the constricting band.

Step 10. Develop Directions for Administering the Rating Scales and/or Checklists. Make some notes about how the evaluator can use the forms for diagnosis of problem areas and how they should be scored.

Step 11. Field Test and Revise the Rating Scales and/or Checklists. (No need to worry about this here--you'll get it later.)



Step 12. Determine How Many Repetitions of the Procedure are Required. Think about the complexity of the procedure.

Step 13. Develop REMEMBER-level Test Items if Necessary.  
In this example, there may be REMEMBER-level questions you will want to ask before the demonstration begins. This is especially important if there are possible safety hazards involved. Review the Red Cross material and make some notes about what REMEMBER-level information might be tested during the USE-PROCEDURE test.

## Feedback

Step 1. Determine TASK LEVEL and CONTENT TYPE. This objective is a USE-UNAIDED PROCEDURE.

Steps 2 and 3. Determine if the Objective Specifies a Product and Determine Whether to Test Product, Process, or Both. We could measure the degree of crippling injury to the victim as a product, but that is unreasonable. The objective specifies that a first aid demonstration is the action to be measured. This is a process. Therefore, in this objective, we are more interested in testing the process; that is, the steps the students perform as they treat the victim.

Step 5. Determine Whether Simulation is Necessary or Desirable. This was specified in the objective.

Step 5. Analyze the Process. Notice that the objective states the victim has a severe reaction to a snakebite. All cases of snakebite should be treated as described under "Give first aid," including those where there is a severe reaction. In this case, we are assuming the closest hospital is over five hours away. The patient is breathing and has a pulse. Below is a sample of how the procedure may be broken into measureable steps:

Give first aid by--

First, keeping the victim lying down and maintain his body temperature.

Second, immobilizing the bitten limb at or below heart level.

1. Apply a constricting band.

- a. Choose a band that is  $3/4$  to  $1-1/2$  inches wide, not as thin as a shoe string.
- b. Apply the constricting band 2 to 4 inches above the bite, towards the heart, and loose enough to slip a finger under.
- c. Do not apply around a joint, or the head, neck, or trunk.
- d. Loosen the band if swelling occurs, but do not remove it.
- e. Check the pulse beyond the bite for blood flow.

2. Make an incision.

- a. Sterilize a sharp knife.
- b. Make 1/2-inch long, shallow cuts, no deeper than just through the skin, extending over the fang marks and the suspected venom deposit (usually lower than the fang marks).
- c. Cuts should be made lengthwise along the limb.
- d. Do not make cross-cut incisions. Do not make cuts on the head, neck, joints, or trunk.

3. Apply suction.

- a. Periodically check the pulse in the limb beyond the bite to be sure blood flow has not stopped.
- b. Apply suction to the bite for 30 minutes with a suction cup or your mouth.

4. Get to the hospital as soon as possible.

Most of the steps are explicit enough, but step 2 requires more explanation about how to sterilize a knife. Also, you may want to consider simulating this step, in order to save time.

Step 7. Determine Whether to Use Checklists and/or Rating Scales. The steps under "Give first aid" can be measured with a checklist because they are simply performed or not. All of step 1 can be measured with a checklist. Step 2b and 2c refer to the cuts and require a rating scale. Steps 2a and 2d require a checklist. Step 3a can be a checklist. Step 3b requires a rating scale.

Steps 8 and 9. Develop Checklist and Develop Rating Scales.  
As an example, the checklist for step 1, applying the constricting band, is developed. Note that characteristics that should be absent are stated negatively on the checklist.

-----	yes	no
Constricting band:		
1a. Band is between 3/4 to 1 1/2 inches wide.	.....	.....
1b. Band is 2 to 4 inches above bite and towards the heart.	.....	.....
Band is loose enough to slip one finger under but not two.	.....	.....
1d. If swelling occurs, loosen band.	.....	.....
Do not remove band.	.....	.....
1e. Check for pulse beyond the bite.	.....	.....
-----		

Notice that steps 1b and 1d have two parts. This is because these steps have more than one action. These steps could have been broken down into smaller steps.

Step 10. Develop Directions for Administering the Rating Scales and/or Checklists. Some of the things you may have noted about evaluating a procedure are that the steps provide an obvious indication of where there are problems, that those problems are usually due to memory lapses, and that diagnosis can be specific and feedback immediate. Look at the directions that are given on page 86 of the handbook. Something like those should be developed for each set of scales/checklists.

In this case, the student should receive supervised remediation for each error until he is able to perform accurately on a retest without help from the evaluator.

Step 11. Field Test and Revise the Rating Scales and/or Checklists. Go to Chapter 6 of the handbook for the section on "Determining Reliability of Checklists and Rating Scales."

Step 12. Determine How Many Repetitions of the Procedure are Required. Based on the complexity of this objective, it was decided that the student must perform the entire procedure correctly one time. (This is the kind of decision that can only be made with the help of a subject matter expert.)

Step 13. Develop REMEMBER-level Test Items if Necessary. Notice that there are some actions in the procedure that the rescuer must remember NOT to do. They could be more dangerous to the victim than the snakebite. For example, the constricting band should not be applied around a joint or the head, neck, or trunk. Also, cuts should not be made on the head, neck, or trunk, and cross-cuts should not be made.

Several REMEMBER-level test items may be given here because of the potential safety hazard to the individual who is the victim. The test items should be given orally and the procedures described in Chapter 3 should be used to develop the items.

## TESTING A USE-CATEGORY OBJECTIVE

### Instructions

In this exercise, you will be given a USE-CATEGORY objective. Your task is to use the guidelines in the "Testing USE-CATEGORY Objectives" section of the handbook to analyze the objective, determine item formats, construct actual items, and develop standards and instructions for scoring. All the information needed for these steps will be provided.

### Exercise

#### Objective

Given a description of the characteristics of a USN guided missile destroyer, the student will write which of the four classes of guided missile destroyers the ship belongs to; KIDD, ADAMS, COONTZ, SHERMAN-HULL or that the ship is not a USN guided missile destroyer.

#### Step 1. Analyze the Objective to Determine the Test Item Domain

This section contains the information you will need to analyze the objective.

The Navy has four classes of guided missile destroyers (DDG): KIDD Class, ADAMS Class, COONTZ Class, and SHERMAN-HULL Class. The KIDD and COONTZ class ships carry Standard-ER missiles and the other two classes carry Tartars. KIDD and ADAMS class ships have two 5-inch guns while the other two classes have only one. KIDD class ships are powered by two gas turbine engines; the other three classes are driven by two geared steam turbine engines. Finally, SHERMAN-HULL and ADAMS class ships have a top speed of 30 knots, and the other two classes, 33 knots.

Step 1A. List the Critical Characteristics that Determine Category Membership. Use the information in the paragraph above to develop a list of the critical characteristics for each class of destroyer.

Step 1B. List exceptions (if any). In this example, there are no exceptions.

Step 1C. List variable characteristics and the Values These May Take. The major variable characteristics of the four classes are:

1. Type of radar: Ships within a class can carry different types of radars; for example some ADAMS class destroyers carry SPS 39s, while others carry SPS 10s and SPS 40s. This is also true of the other classes. Therefore, if you know the radar a ship carries, you can't tell the class because there is at least one ship in each class with that type of radar.

2. Number of digits in the hull number: All classes have ships with one- and two-digit hull numbers.

Step 1D. Use the Critical and Variable Characteristics to Determine the Diagnostic Requirements and Specify the Types of Items Needed. For this step specify a complete set of item types. Use the chart procedure described in the handbook. Do not include type of radar as a variable characteristic; however, do include hull number. Make some notes about how radar might be included.

Step 2. Determine item formats

Try to think about the "job" and make a decision about an appropriate item format.

Step 3. Construct Actual Test Items

Assume the the item types specified in step one are enough.

Step 4. Develop Standards and Instructions for Scoring and Diagnosis

Make some notes about the standards you would set for the items you developed and about the kinds of instructions you would provide for scoring and diagnosis.

Step 5. Develop REMEMBER-level Test Items if Necessary

Since this is a written test, we will assume that REMEMBER-level items have already been tested.

## Feedback

### Step 1A. List critical characteristics:

The characteristics of KIDD class destroyers are:

1. Missiles: SAM Standard-ER
2. Guns: Two 5-inch
3. Main Engines: Two gas turbines
4. Speed: 33 knots

The characteristics of ADAMS class destroyers are:

1. Missiles: SAM Tartar
2. Guns: Two 5-inch
3. Main Engines: Two geared steam turbines
4. Speed: 30 knots

The characteristics of COONTZ class destroyers are:

1. Missiles: SAM Standard-ER
2. Guns: One 5-inch
3. Main Engines: Two geared steam turbines
4. Speed: 33 knots

The characteristics of SHERMAN-HULL class destroyers are:

1. Missiles: SAM Tartar
2. Guns: One 5-inch
3. Main Engines: Two geared steam turbines
4. Speed: 30 knots

Step 1B. List exceptions (if any). There are no exceptions.

Step 1C. List variable characteristics and the Values These May Take. No feedback required.



Step 1D. Use the Critical and Variable Characteristics to Determine the Diagnostic Requirements and Specify the Types of Items Needed. In this situation, we are dealing with four classes of ships, some of which have the same characteristics. Therefore, we will specify the item types for each category one at a time, examine the items to eliminate duplications caused by classes having the same characteristics, and finally specify additional items for the variable characteristics.

Items for KIDD Class: This class has four critical characteristics, so we will need five sample ( $n + 1$ ) items. We will need one item that has Standard-ER missiles, two 5-inch guns, two gas turbine engines, and a speed of 33 knots--this is our true example. Next, we will need an item that has different missiles, one that has a different number of guns, one that has different engines, and one that has a different speed.

The item samples required for the other classes of ships follow the same pattern as those required for the KIDD class. A chart for KIDD class ships would look like the following:

Chart for KIDD Class Ships

Hull #	Guns		Speed		Engines		Missiles	
	1	2	30	33	Gas	Steam	ERs	Tartar
41		x		x	x		x	
32		x		x	x			x
3	x			x	x		x	
14		x		x		x	x	
5		x	x		x		x	

This chart can be used for all the ship classes because they all have the same critical characteristics.

The information from the chart can be turned into a pool of items. Below are 20 items.

#### KIDD

Ship 41 Standard-ER, two 5-inch guns, two gas turbines, 33 knots  
Ship 32 Tartar, two 5-inch guns, two gas turbines, 33 knots  
Ship 3 Standard-ER, one 5-inch gun, two gas turbines, 33 knots  
Ship 14 Standard-ER, two 5-inch guns,  
two geared steam turbines, 33 knots  
Ship 5 Standard-ER, two 5-inch guns, two gas turbines, 30 knots

#### ADAMS

Ship 66 Tartar, two 5-inch guns, two geared steam turbines, 30 knots  
Ship 37 Standard-ER, two 5-inch guns,  
two geared steam turbines, 30 knots  
Ship 58 Tartar, one 5-inch gun, two geared steam turbines, 30 knots  
Ship 9 Tartar, two 5-inch guns, two gas turbines, 30 knots  
Ship 18 Tartar, two 5-inch guns, two geared steam turbines, 33 knots

#### COONTZ

Ship 11 Standard-ER, one 5-inch gun,  
two geared steam turbines, 33 knots  
Ship 2 Tartar, one 5-inch gun, two geared steam turbines, 33 knots  
Ship 33 Standard-ER, two 5-inch guns,  
two geared steam turbines, 33 knots  
Ship 74 Standard-ER, one 5-inch gun, two gas turbines, 33 knots  
Ship 25 Standard-ER, one 5-inch gun,  
two geared steam turbines, 30 knots

#### SHERMAN-HULL

Ship 6 Tartar, one 5-inch gun, two geared steam turbines, 30 knots  
Ship 17 Standard-ER, one 5-inch gun,  
two geared steam turbines, 30 knots  
Ship 48 Tartar, two 5-inch guns, two geared steam turbines, 30 knots  
Ship 1 Tartar, one 5-inch gun, two gas turbines, 30 knots  
Ship 20 Tartar, one 5-inch gun, two geared steam turbines, 33 knots

Notice that ships 14 and 33, 66 and 48, 58 and 6, and 2 and 20 are identical; therefore, 33, 48, 6, and 20 can be deleted.

The variable characteristics listed above can be added to each list of ship descriptions so that all relevant values of the variable characteristics are represented. This has already been done for the hull numbers in the sample above. To complete the listing of variable characteristics, each ship should be given a radar, taking care not to correlate radar type with class. For example, Ship 6 could be given an SPS 39 radar in addition to the characteristics listed above.

## Step 2. Determine Item Formats

The "job" this objective supports is not entirely clear. Presumably, Navy officers are supposed to be able to identify what class a ship belongs to based on its characteristics. The officers should have memorized the possible classes and be able to give the correct class name when presented with a set of characteristics. They should also be able to tell when a set of characteristics does not describe any class of ship. Therefore, the item format should be fill-in-the-blank.

## Step 3. Construct Actual Test Items

For this exercise, we will assume that 16 items are enough. Thus, all that remains to be done is to put the sample items into the correct format; that is, fill-in-the-blank. Write one or two sample items.

## Step 4. Develop Standards and Instructions for Scoring and Diagnosis

The implied standard in the objective is "with no errors." This will be the standard used for this exercise.

A diagnostic plan must be developed so that remediation can be accurately described. Possible diagnoses for each possible answer for each item should be identified. Below are diagnosis for two of the sample items.

Item	Response	Possible Diagnosis
1. Standard ER, one 5-inch gun, two steam turbines, 33 knots.	KIDD	Student has KIDD and COONTZ Class confused. May know that KIDD has Standard-ER Missile and a speed of 33 knots but is unsure of type of engine and number of guns. Check response to KIDD class item and other distractors with Standard-ER and 33 knots.
	ADAMS	Student has ADAMS and COONTZ Class confused. May know that ADAMS has steam turbine engines but is unsure of the other characteristics. Check response to ADAMS class item and other distractors with steam turbine engines.

COONTZ                      Correct.

SHERMAN-HULL      Student has SHERMAN-HULL and COONTZ Class confused. May know that SHERMAN-HULL has one 5-inch gun and steam turbine engines but is unsure of the other characteristics. Check response to SHERMAN-HULL class item and other distractors with one 5-inch gun and steam turbine engines.

Not a DDG              Student is probably guessing and needs to review the characteristics for COONTZ class ships.

2. Tartar,              KIDD                      Student is probably focusing on one 5-inch gun, gas turbine characteristic and two gas turbines, believes that anything with a 30 knots. gas turbine is a KIDD class ship.

ADAMS                      Student may know that ADAMS class ships have Tartar missiles and a speed of 30 knots but is unsure of the other characteristics. Check response to ADAMS class item and other distractors with Tartar missiles and 30 knots speed.

COONTZ                      Student may be focusing on the number of 5-inch guns. Responses to COONTZ and SHERMAN-HULL items should be checked as well as responses to other distractors with one 5-inch gun.

SHERMAN-HULL      Student may know all characteristics of SHERMAN-HULL except engine type. Responses to KIDD class item and other items with gas turbines should be checked.

Not a DDG              Correct.

The rest of the items would have similar diagnostic information.

## TESTING A USE-RULE OBJECTIVE

### Instructions

In this exercise, you will be given a USE-RULE Objective. Your task is to use the guidelines in the "Testing USE-RULE Objectives" section of the handbook to analyze the objective, determine item formats, construct actual items, and develop standards and instructions for scoring. All the information you need is given below.

### Exercise

#### Objective

You are a golfer who hits a 7 iron 150 yards under "normal" conditions. The task is to select the right club to hit from 150 yards out under a variety of conditions. The variables that must be considered are wind, pin placement, and air temperature.

The objective is: Given an approach shot of 150 yards, the golfer will evaluate wind direction, pin placement, and air temperature and select the appropriate iron. For the purposes of this example, it is assumed that the golfer normally hits a 7 iron 150 yards.

#### Step 1. Analyze the Objective to Determine the Test Item Domain

This section contains the information you will need to analyze the objective.

#### Rule Statement

The three factors are cumulative. After you have evaluated the first factor, you must take the club you have selected and apply the second factor to it. The same is true for the third factor.

Wind: If the wind is toward you, subtract one club; if there is no wind, do not change clubs; if the wind is behind you, add one club. Next, evaluate pin placement.

Pin Placement: If the pin is at the back of the green, subtract one club; if the pin is in the middle, do not change clubs; if the pin is at the front, add one club. Next, evaluate air temperature.

Air temperature: If the air temperature is below 70 degrees fahrenheit, subtract one club; if it between 70 and 85 degrees, do not change clubs; if it is above 85 degrees, add one club.

From this information, you should be able to develop a flow chart. You should also decide how to test the action boxes and what paths through the flow chart should be tested.

Step 2. Determine Item Formats

If more than one format is appropriate, list all appropriate formats.

Step 3. Construct Actual Test Items

Determine how many paths we need to trace through the flow chart in order to test all the decisions and steps.

Step 4. Develop Standards and Instructions for Scoring and Diagnosis

Think about the "job" and set standards accordingly. Also, make some notes about scoring instructions.

Step 5. Develop REMEMBER-level Test Items if Necessary

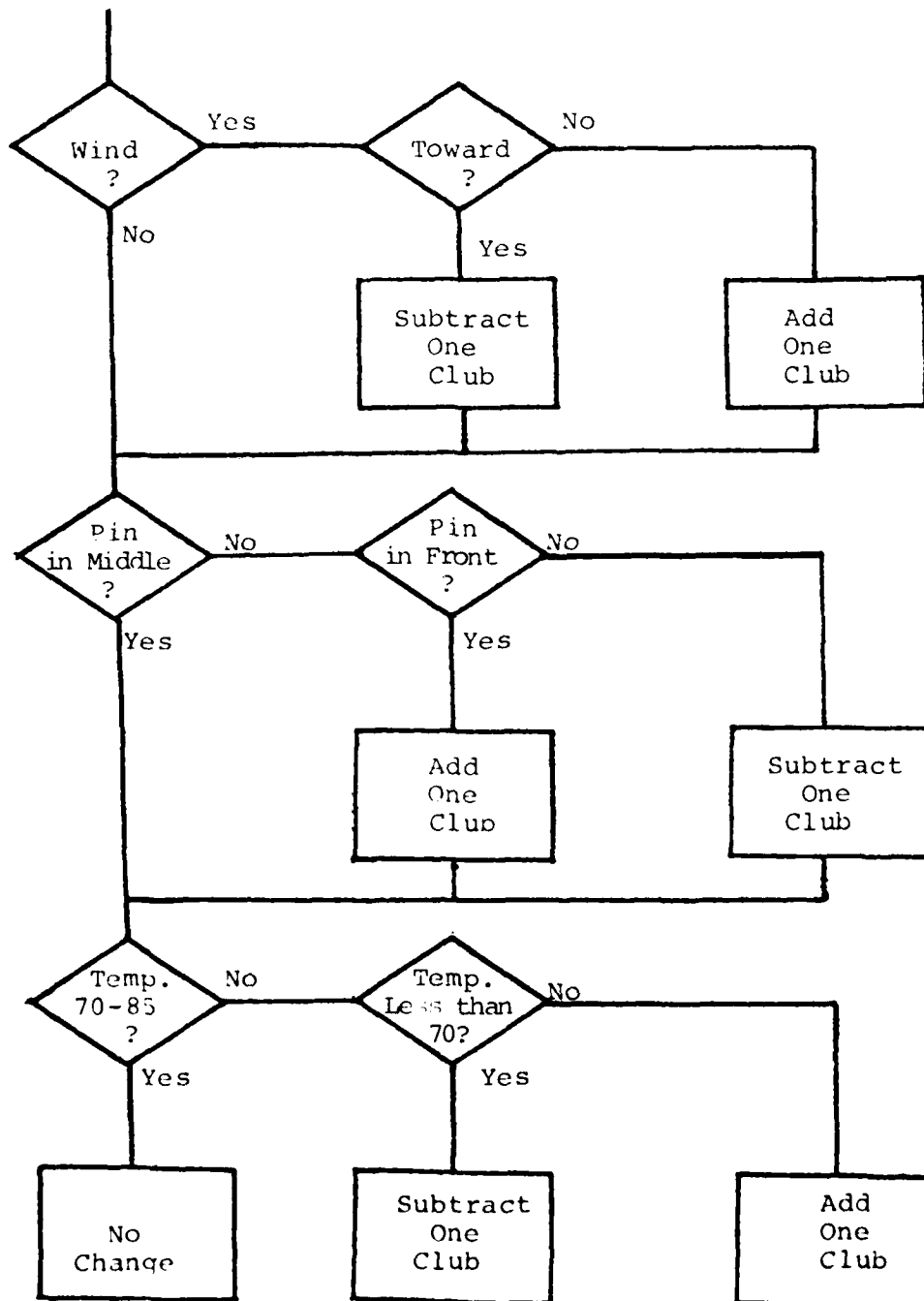
For this example, assume that REMEMBER-level items have already been tested.

Feedback

Step 1. Analyze the Objective to Determine the Test Item Domain

A flow chart for this task is shown below:

Club = 7 Iron



It should be noted that this is part of a larger rule in which golfers must make club selections from a variety of distances under a variety of conditions.

#### Step 2. Determine Item formats

It is appropriate to use written test items that describe a situation and require the student to make a decision. Therefore, this example is similar to the fowl example on page 114 of the handbook.

Given that written test items will be used, the question is whether constructed-response or selected-response test items will be used. If you "remember the job," you will realize that either type can be used if they are constructed properly. For constructed-response items, descriptions of situations could be written and students could be required to write the appropriate club number. For selected-response items, the most appropriate format is matching situation descriptions with club numbers. This is because the task on the job is to evaluate the situation and select a club from among the 13 or 14 clubs in the bag. A matching item should include all the clubs in the bag for potential matches. Note that standard multiple-choice items (i.e., those with four or five alternatives) would not work because not all possible clubs could be included as distractors.

#### Step 3. Construct Actual Test Items

Three paths through the chart will test all the decisions and steps. In order to be diagnostic, responses should be recorded after each step for each path through the chart. Note that one possible correct answer is a 10 iron. Students should be told prior to testing that a 10 iron is called a pitching wedge.

#### Step 4. Develop Standards and Instructions for Scoring and Diagnosis

Because the job requires accuracy, the standards should be completely correct on all items. Diagnosis is similar to diagnosis for category tasks. If the student selects a club higher or lower than the correct club, it can be inferred that the decision rule(s) has/have not been followed, or that the student is guessing. The latter would be especially true if a club not in the 150-yard range were selected.

#### Step 5. Develop REMEMBER-level Test Items if Necessary

For the purposes of this example, no previous REMEMBER-level objectives are included.



## TESTING A USE-PRINCIPLE OBJECTIVE

### Instructions

In this exercise, you will be given a USE-PRINCIPLE objective. Your task is to use the guidelines in the "Testing USE-PRINCIPLE Objectives" section of the handbook to analyze the objective, determine item formats, construct actual items, and develop standards and instructions for scoring. All the information you need from technical publications is given below.

### Exercise

#### Objective

Given a diagram of a spring-loaded reducing valve, the student will (1) explain how the valve operates to maintain reduced output pressure, (2) predict the effects of clogged passages, sticking valve-piston stems, and a ruptured diaphragm on the valve's operation, and (3) diagnose the probable reasons for lack of flow or excessive output pressure.

#### Step 1. Analyze the Objective to Determine the Test Item Domain

This section contains the information you will need to analyze the objective.

An explanation of how a spring-loaded reducing valve works and two diagrams of a spring-loaded reducing valve are given on the following page. The picture on the left shows the valve during normal operation: high-pressure fluid enters and reduced pressure fluid exits. The picture on the right shows the valve when outlet pressure increases. The purpose of the valve is to control or hold output pressure below some value.

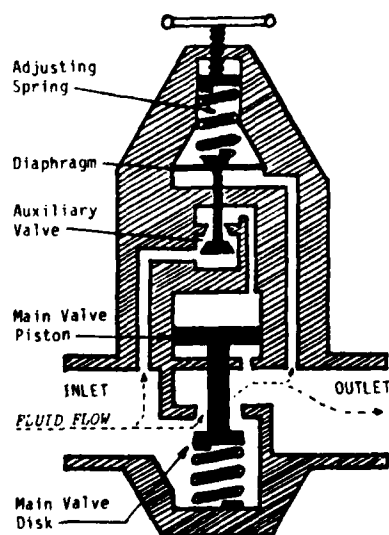
The following explanation of the valve's operation is taken from NAVEDTRA 10524-E, Machinist's Mate 3 & 2 Rate Training Manual.

"The principal parts of a spring-loaded reducing valve are: (1) the main valve, an upward-seating valve which has a piston on top of its stem; (2) an upward-seating auxiliary (or controlling) valve [with its stem attached to]; (3) a controlling diaphragm; and (4) an adjusting spring.

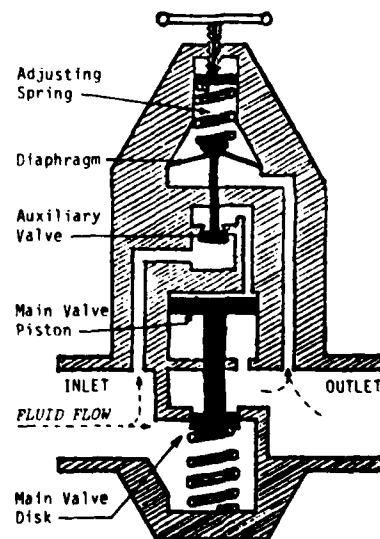
"High pressure fluid enters the valve on the inlet side and acts against the main valve disk, tending to close the main valve. However, high-pressure fluid is also led through ports to the auxiliary valve, which controls the admission of high-pressure fluid to the top of the main valve piston. The piston has a larger surface area than the main valve disk; therefore, high-pressure fluid acting on the top of the main valve piston will tend to open the main valve, and so allow fluid at reduced pressure to flow out the discharge side.

"But what makes the auxiliary valve open to allow high-pressure fluid to get to the top of the main valve piston? The controlling diaphragm exerts a downward pressure upon the auxiliary valve stem, and this tends to open the valve. However, reduced-pressure fluid is led back to the chamber beneath the diaphragm, and this fluid exerts a pressure upward on the diaphragm, which tends to close the auxiliary valve. The position of the auxiliary valve, therefore, is determined by the position of the controlling diaphragm.

"The position of the diaphragm at any given moment is determined by the relative strength of two opposing forces: (1) the downward force exerted by the adjusting spring, and (2) the upward force which is exerted on the underside of the diaphragm by the reduced-pressure fluid. These two forces are continually seeking to reach a state of balance, and, because of this, the discharge pressure of fluid is kept constant as long as the amount of fluid is kept within the capacity of the valve."



OPEN



CLOSED

The first step is to use the description above to construct item types for the explanation, prediction, and diagnosis tasks required in the objective. Use the methods in the handbook to construct explanation, prediction, and diagnosis statements.

Step 2. Determine Item Formats

For this exercise, you should next determine what item format(s) to use. Make some choices in the space below, according to the guidelines in the handbook. If you choose multiple-choice items, you should determine whether or not to use "written simulations."

Step 3. Construct Actual Test Items

For purposes of this exercise, construct a few items for the explanation, prediction, and diagnosis tasks required in the objective. You do not have to build complete sets of items for all the tasks; just do enough to show how you would do it.

Step 4. Develop Standards and Instructions for Scoring and Diagnosis

Make some notes about the standards you would set for the items you developed and about the kinds of instructions you would provide for scoring and diagnosis.

Step 5. Develop REMEMBER-level Test Items if Necessary

Since this is a written test, we will assume that earlier items have already tested part names, etc. You don't have to do it here.

## Feedback

### Step 1. Analyze the objective.

The first step is to write each cause-effect statement for the explanation task. This is done below simply by revising the explanation taken from the manual:

1. High-pressure fluid enters the valve on the inlet side and acts against the main valve disk, tending to close the main valve.
2. High-pressure fluid is also led through ports to the auxiliary valve.
3. The spring and controlling diaphragm above the auxiliary valve push down on the valve stem, tending to open the auxiliary valve.
4. The auxiliary valve controls the admission of high-pressure fluid to the top of the main valve piston.
5. The piston has a larger surface area than the main valve disc, so high-pressure fluid acting on the top of the main valve piston will tend to open the main valve.
6. This will allow fluid at reduced pressure to flow out the discharge side.
7. This reduced pressure fluid is also led through ports to the underside of the auxiliary valve diaphragm.
8. If the discharge pressure increases, increased pressure is led to the underside of the diaphragm, pushing it up.
9. When the diaphragm rises, this closes the auxiliary valve.
10. When the auxiliary valve closes, this reduces pressure to the top of the main valve piston.
11. High-pressure fluid from the inlet side tends to close the main valve.
12. When the main valve closes, pressure in the discharge side is reduced.

Statements 1 through 12 above explain the valve's normal operation. These will be used to build explanation items.

For prediction items, we need to assume new "boundary conditions," and then revise the explanation above. The objective calls for predictions for "clogged passages, sticking valve stems, or a ruptured diaphragm."

If the high-pressure passage from the inlet side of the valve to the auxiliary valve were clogged, the explanation would be:

1. High-pressure fluid enters the valve on the inlet side and acts against the main valve disk, tending to close the main valve.
2. No high-pressure fluid is led through ports to the auxiliary valve, because the port is clogged.
3. The spring and controlling diaphragm above the auxiliary valve push down on the valve stem, tending to open the auxiliary valve.
4. No high-pressure fluid flows through the auxiliary valve to the top of the main valve piston.
5. Therefore, the main valve remains closed.

If the low-pressure passage from the discharge side of the valve to the bottom of the diaphragm were clogged, the explanation would be:

1. High-pressure fluid enters the valve on the inlet side and acts against the main valve disk, tending to close the main valve.
2. High-pressure fluid is also led through ports to the auxiliary valve.
3. The spring and controlling diaphragm above the auxiliary valve push down on the valve stem, tending to open the auxiliary valve.
4. The auxiliary valve controls the admission of high-pressure fluid to the top of the main valve piston.
5. The piston has a larger surface area than the main valve disc, so high-pressure fluid acting on the top of the main valve piston will tend to open the main valve.
6. This will allow fluid at reduced pressure to flow out the discharge side.
7. This reduced pressure fluid is not led through ports to the underside of the auxiliary valve diaphragm, because the ports are clogged.

8. If the discharge pressure increases, increased pressure is not led to the underside of the diaphragm, so it is not pushed up.

9. The auxiliary valve does not close.

10. The main valve does not tend to close.

11. Since the main valve does not close, pressure in the discharge side is not reduced.

Similar explanations can be constructed for sticking valve stems and for the ruptured diaphragm. These other explanations will be similar to the two given above, because sticking valve stems will prevent the valves from working as they should, and a broken diaphragm will prevent the auxiliary valve from operating when required.

The objective also requires the student to "diagnose probable reasons for lack of flow or excessive outlet pressure." These are the symptoms the student will deal with, so we don't have to identify them. (Note that, if the objective was less specific and just said "troubleshoot the valve," then we would have to consult an subject matter expert to identify the symptoms that most often occur or are most critical.) To identify the causes for the symptoms of lack of flow or excessive outlet pressure, we would simply trace backwards through the explanations above. For example, lack of flow is caused by the main valve failing to open. This means pressure is not getting to the top of the main valve piston, or that pressure is there, but the piston is stuck. Lack of pressure at the top of the main valve piston means that the auxiliary valve is stuck closed, or that the high pressure passage to the auxiliary valve is clogged.

A similar process is followed for the other symptom--excessive outlet pressure. It is often necessary to consult an subject matter expert to determine the possible causes for each observed symptom.

## Step 2. Determine Item Formats

The best type of item for this objective is a one-on-one oral test, with short-answer items. If you had to use a written test, then fill-in items could be used. Multiple-choice items are also acceptable if the items are carefully developed but are not the best choice. One reason constructed-response tests are most appropriate here is that the job the student will perform after training will probably not consist of selected-response situations. For example, valves will not have four possible faults listed on them. Another reason is that multiple-choice items tend to have hints to other items in them.

If you did select multiple-choice items, written simulations should not be used. The reason for this is that the objective only requires the student to give probable reasons or causes for observed symptoms, not to perform additional diagnostic tests. Therefore, we can't really ask a series of items that trace out a troubleshooting process.

## Step 3. Construct Actual Test Items

Your task here was to construct a few items for the explanation, prediction, and diagnosis tasks required in the objective.

If you chose a short-answer oral test format, you would simply have items like:

"Explain how the spring-loaded reducing valve operates."

You would also have to give clear directions to the student about the form and content of an acceptable answer.

If you chose a fill-in test format, you would turn each of the explanation statements into questions with key words left out:

"1. High-pressure fluid enters the valve on the inlet side, and acts against the main valve disc. This causes the valve to \_\_\_\_\_."

2. High-pressure fluid is also led through ports to the \_\_\_\_\_."

(etc.)"

If you chose a multiple-choice written test, then each of the explanation statements from step 1 would be turned into multiple-choice items. The distractors would have to be developed carefully:

"1. High-pressure fluid enters the valve on the inlet side and acts against the main valve disk; this causes the main valve to

- a. open.
- b. close.
- c. remain in the same position.

2. High-pressure fluid is also led through ports to the

- a. outlet side of the valve.
- b. underside of the diaphragm.
- c. auxiliary valve.
- d. underside of the main-valve piston.

3. The spring and controlling diaphragm above the auxiliary valve push down on the valve stem, tending to

- a. open the auxiliary valve.
- b. reduce pressure under the diaphragm.
- c. close the main valve.
- d. close the auxiliary valve."

Prediction items would be constructed similarly, except that you would use the explanations constructed for changes in the initial or "boundary" conditions:

"1. If the high-pressure passage from the inlet side of the valve to the auxiliary valve were clogged, the main valve would

- a. remain open.
- b. remain closed.
- c. operate normally."



The diagnosis items are constructed simply by asking for possible causes for each observed symptom:

"1. The spring-loaded reducing valve fails to open, even when high-pressure fluid is present on the inlet side of the valve. Which of the following are possible causes for this failure? (Choose all of the following that apply).

- a. The high-pressure passage to the auxiliary valve is clogged.
- b. The diaphragm is ruptured.
- c. The auxiliary valve stem is stuck in the closed position.
- d. The main valve stem is stuck in the closed position.
- e. The auxiliary valve stem is stuck in the open position."

Note that, for multiple-choice items, you must attempt to make the incorrect alternatives diagnostic so that they can help identify students' misconceptions.

Step 4. Set Standards and Develop Instructions for Scoring and Diagnosis.

The implied standard in the original objective is "100 percent correct," and there is no reason to set a lower standard for any of the items constructed here.

The next step is to develop instructions for scoring and diagnosis. Instructions are described below for the sample items we specified. The instructions for your items should be similar.

If you chose a short-answer oral test format, you would simply have items like:

"Explain how the spring-loaded reducing valve operates."

You would also have given clear directions to the student about the form and content of an acceptable answer. Instructions for scoring this item should list the critical points in the explanation that the student should give and should specify how credit is given for each of them. Errors that students frequently make should be listed so that they can be diagnosed.

If you chose a fill-in test format, each of the explanation statements was turned into a question with a key word left out:

- "1. High-pressure fluid enters the valve on the inlet side and acts against the main valve disc. This causes the valve to \_\_\_\_\_.
  2. High-pressure fluid is also led through ports to the \_\_\_\_\_.
- (etc.)"

For each of these questions, correct answers (and synonyms) should be given. For example, for item 1 above, correct answers are "close," "lift," or "shut." Incorrect answers should also be listed, together with diagnoses for their occurrence. For example, for item 1, the most common wrong answer would be "open." A student might give this answer if he did not understand the valve, or if he was thinking ahead in the explanation. This could be checked with follow-up questions. For item 2 above, the correct answer is "the auxiliary valve." The most likely incorrect answer is "the top of the main valve piston." High-pressure fluid does reach the top of the piston, but only after it passes through the auxiliary valve, which must be open.

If you chose a multiple-choice written test, each of the explanation statements was turned into a multiple-choice item.

- "1. High-pressure fluid enters the valve on the inlet side and acts against the main valve disk; this causes the main valve to
  - a. open.
  - b. close.
  - c. remain in the same position.
2. High-pressure fluid is also led through ports to the
  - a. outlet side of the valve.
  - b. underside of the diaphragm.
  - c. auxiliary valve.
  - d. underside of the main-valve piston.
3. The spring and controlling diaphragm above the auxiliary valve push down on the valve stem, tending to
  - a. open the auxiliary valve.
  - b. reduce pressure under the diaphragm.
  - c. close the main valve.
  - d. close the auxiliary valve."

Again, for these items, the correct answers are noted and possible misconceptions for each of the incorrect alternatives are identified, just as we did above for the fill-in items.

Instructions for scoring prediction items would be constructed similarly.

The diagnosis items were constructed simply by asking for possible causes for each observed symptom. Instructions for scoring and diagnosis should again give the correct answers, and should give possible misconceptions that might have led to wrong answers. For example, in the following item, alternatives a, c, and d are correct:

"1. The spring-loaded reducing valve fails to open, even when high-pressure fluid is present on the inlet side of the valve. Which of the following are possible causes for this failure? (Choose all of the following that apply).

- a. The high-pressure passage to the auxiliary valve is clogged.
- b. The diaphragm is ruptured.
- c. The auxiliary valve is stuck in the closed position.
- d. The main valve is stuck in the closed position.
- e. The auxiliary valve is stuck in the open position."

If alternative b is selected, the student probably thinks that pressure on the diaphragm tends to open the auxiliary valve, rather than close it. If alternative e is selected, the student does not know that high-pressure fluid from the auxiliary valve opens the main valve.

Instructions for scoring and diagnosis should also include remedial actions to be taken for incorrect answers.

Step 5. Develop REMEMBER-level Items if Necessary

Assume that all REMEMBER-level items have been tested previously.

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